PITT RIVERS MUSEUM
UNIVERSITY OF OXFORD

Metallurgical Reports on British and Irish Bronze Age Implements and Weapons in the Pitt Rivers Museum

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DESCRIPTIONS OF THE PHOTOMICROGRAPHS OF ANCIENT IMPLEMENTS

EARLY BRONZE AGE

PLATE IV

25 Ireland. Axe with slight flanges.

(1) *Etched (Aqueous ferric chloride)* × 100
The cutting-edge, showing recrystallization. Some pools of $\alpha\delta$ eutectoid are present in the section.

(2) *Etched (Aqueous ferric chloride)* × 50
Typical structure in the mass of the metal remote from the cutting-edge, showing recrystallization and high proportion of $\alpha\delta$ eutectoid.

(3) *Etched (Aqueous ferric chloride)* × 100
Typical structure in the mass of the metal remote from the cutting-edge, showing recrystallization and high proportion of $\alpha\delta$ eutectoid.

PLATE V

31 Cookstown, Co. Tyrone, Ireland. Flanged axe.

(1) *Etched (Alcoholic ferric chloride)* × 50
The cutting-edge, showing excellent preservation of the metal. The dark islands seen in this view are pools of $\alpha\delta$ eutectoid.

(2) *Etched (Alcoholic ferric chloride)* × 100
A section taken in the mass of the metal remote from the cutting-edge. The strain-banded twinned crystals, and distribution of $\alpha\delta$ eutectoid (dark islands), is typical of the specimen examined as a whole.

(3) *Etched (Alcoholic ferric chloride)* × 100
Showing strain-banded twinned crystals at the side of the section remote from the cutting-edge. This is typical of the mass of the metal as a whole. In this picture the $\alpha\delta$ eutectoid shows as dark grey.

PLATE VI

32 Slieve Gallion, Co. Londonderry, Ireland. Flanged axe.

(1) *Etched (Alcoholic ferric chloride)* × 50
The cutting-edge. At the tip is an area where there has been a marked corrosion attack. Recrystallization and $\alpha\delta$ eutectoid may also be seen.

(2) *Etched (Alcoholic ferric chloride)* × 100
A typical section in the mass of the metal remote from the cutting-edge, showing twinned crystals and distribution of $\alpha\delta$ eutectoid. In this specimen the eutectoid has etched to a dark colour.

(3) *Etched (Alcoholic ferric chloride)* × 200
Showing strain banding in crystals adjacent to the cutting-edge. Also $\alpha\delta$ eutectoid.

MIDDLE BRONZE AGE

PLATE VII

48 Ireland. Palstave.

(1) *Etched (Ammonia hydrogen peroxide)* ×30
The damaged cutting-edge, showing bending of the residual cores due to hammering and flattening of the edge.

(2) *Etched (Alcoholic ferric chloride)* ×100
Typical recrystallization in the mass of the metal remote from the cutting-edge. The structure is superimposed on relics of dendritic shading. Strain banding of the equi-axed twinned crystals was not observed. In this field two small islands of $\alpha\delta$ eutectoid are seen; also a number of small non-metallic inclusions.

(3) *Etched (Alcoholic ferric chloride)* ×200
Structure adjacent to the cutting-edge, showing strain-banded and distorted crystals.

PLATE VIII

50 Worstead Common, Norfolk. Palstave.

(1) *Unetched* ×30
The cutting-edge, showing zones of severe intercrystalline penetrative corrosion upon the side of the specimen. Otherwise the metal is clean and sound.

(2) *Etched (Ammonia hydrogen peroxide)* ×200
View adjacent to the cutting-edge, showing recrystallized structure of very small twinned crystals.

(3) *Etched (Ammonia hydrogen peroxide)* ×200
Showing increased grain size in the mass of the metal remote from the cutting-edge. There is considerable strain banding of the crystals.

PLATE IX

51 Suffolk. Palstave with one loop.

(1) *Etched (Ammonia hydrogen peroxide)* ×30
The cutting-edge at low magnification. Relics of dendritic shading, and some porosity, are seen.

(2) *Etched (Ammonia hydrogen peroxide)* ×200
The structure adjacent to the cutting-edge, showing recrystallization, and some crystals with strain lines; $\alpha\delta$ eutectoid and porosity are also seen.

PLATES IX, X

52 Suffolk. Palstave with one loop.

(1) *Etched (Alcoholic ferric chloride)* ×30
The cutting-edge, showing areas of very severe corrosion attack.

(2) *Etched (Alcoholic ferric chloride)* ×100
Typical structure of equi-axed twinned crystals in the mass of metal remote from the cutting-edge. In this particular field not much $\alpha\delta$ eutectoid is visible.

(3) *Etched (Alcoholic ferric chloride)* ×200
A field taken adjacent to the cutting-edge, showing slip-banded twinned crystals.

PLATES X, XI

54 Mettingham, Suffolk. Palstave with one loop.

(1) *Unetched* ×20
The cutting-edge, showing high porosity.

(2) *Etched (Alcoholic ferric chloride)* ×200
Showing recrystallization and severe intercrystalline penetrative attack and corrosion at the cutting-edge.

(3) *Unetched* ×100
Adjacent to the cutting-edge: showing intercrystalline penetration and corrosion along crystallographic planes.

(4) *Etched (Alcoholic ferric chloride)* ×100
Showing typical recrystallization in the mass of the metal remote from the cutting-edge. Small pools of $\alpha\delta$ eutectoid are present, and small non-metallic inclusions which are probably of slag origin. The crystals are superimposed upon slight relics of dendritic shading.

PLATES XII, XIII

55 Near Pusey, Berkshire. Palstave.

(1) *Etched (Ammonia hydrogen peroxide)* ×50
The cutting-edge, showing residual core shading, and bending of the structure at the extreme tip due to mechanical damage.

(2) *Etched (Alcoholic ferric chloride)* ×100
Structure adjacent to the cutting-edge, showing somewhat distorted and strain-banded twinned crystals. One of the very few pools of $\alpha\delta$ eutectoid can be seen.

(3) *Etched (Alcoholic ferric chloride)* ×100
The structure slightly further removed from the cutting-edge, showing characteristic strain-banded twinned crystals with but little distortion. No $\alpha\delta$ eutectoid is seen, but there are some small non-metallic inclusions.

(4) *Etched (Alcoholic ferric chloride)* ×100
Showing recrystallization remote from the cutting-edge, and increased grain size. There is still some strain banding of the twinned crystals, and there are also some very small non-metallic inclusions, probably of slag origin.

PLATES XIII, XIV

56 From the Thames, Wandsworth, London. Palstave.

(1) *Etched (Alcoholic ferric chloride)* ×20
The cutting-edge at low magnification, showing the dendritic structure typical of the whole section examined.

(2) *Etched (Alcoholic ferric chloride)* ×200
A small section of the cutting-edge. Any $\alpha\delta$ eutectoid in the section examined would appear to have segregated to the extreme tip of the cutting-edge. Considerable corrosive penetration is also to be seen.

(3) *Etched (Alcoholic ferric chloride)* ×100
Showing severe corrosion attack at the cutting-edge. One concentration of inter-dendritic $\alpha\delta$ eutectoid may be seen at the edge of the section.

PLATES XIV, XV

58 Ireland. Palstave.

(1) *Etched (Alcoholic ferric chloride)* ×20
The damaged cutting-edge viewed at low power. The edge has been damaged and flattened by mechanical action, and there has also been severe penetrative corrosion attack. In this view are seen three cracks which are more clearly seen at higher magnification in (3).

(2) *Etched (Alcoholic ferric chloride)* ×100
A section showing typical recrystallization and αδ eutectoid in the mass of the metal remote from the cutting-edge.

(3) *Etched (Alcoholic ferric chloride)* ×100
View at one edge of the specimen remote from the cutting-edge, showing typical recrystallization and the considerable quantity of αδ eutectoid.

(4) *Etched (Alcoholic ferric chloride)* ×50
The structure adjacent to the cutting-edge. In this part of the metal only, are three marked diagonal cracks.

PLATES XV, XVI

60 Ireland (?). Palstave.

(1) *Unetched* ×30
The cutting-edge, showing severe corrosive attack. The core of the metal is clean and remarkably free from defects.

(2) *Etched (Alcoholic ferric chloride)* ×100
Showing typical recrystallization in the mass of the metal remote from the cutting-edge. Here there is very marked increase in grain size as compared with recrystallization in the zone of the cutting-edge.

(3) *Etched (Alcoholic ferric chloride)* ×200
View near edge of section, showing recrystallization and intercrystalline penetration and corrosion on crystallographic planes.

(4) *Etched (Alcoholic ferric chloride)* ×100
As (3) above, but wider field.

PLATES XVII, XVIII

63 Co. Mayo, Ireland. Haft-flanged axe.

(1) *Unetched* ×50
The cutting-edge, showing the elongated αδ eutectoid, most probably indicating hot-working of the metal at some time during fabrication.

(2) *Etched (Alcoholic ferric chloride)* ×50
The cutting-edge. In this section there are recrystallization, elongated αδ eutectoid, and faint relics of residual coring.

(3) *Etched (Alcoholic ferric chloride)* ×100
Showing a typical structure at the edge of the section remote from the cutting-edge. The twinned crystals exhibit strain banding. The αδ eutectoid, which has etched a dark colour, has been plastically flowed, suggesting hot-working of the metal at some time during its fabrication.

(4) *Etched (Alcoholic ferric chloride)* ×100
Showing typical recrystallization in the mass of the metal remote from the cutting-edge. Some strain banding of the twinned crystals is observed. There is also a considerable quantity of αδ eutectoid which in this specimen has etched to a dark colour.

PLATE XVIII

64 Co. Mayo, Ireland. Wing-flanged palstave.

(1) *Etched (Ammonia hydrogen peroxide)* ×20
The damaged cutting-edge. Relics of residual coring show how the metal has been crushed and flattened by mechanical damage. Two areas of severe corrosive penetration are seen at the right-hand side of the field.

(2) *Etched (Alcoholic ferric chloride)* ×100
Recrystallization in the metal remote from the cutting-edge. Here the twinned crystals, which do not exhibit slip banding, are superimposed upon relics of dendritic shading. A number of islands of αδ eutectoid are also to be seen.

PLATE XIX

65 Co. Mayo, Ireland. Flanged axe.

(1) *Unetched* ×50
The cutting-edge, showing penetrative corrosion attack, and an area of general unsoundness.

(2) *Etched (Ammonia hydrogen peroxide)* ×50
Showing full dendritic structure in the vicinity of the cutting-edge. A typical structure for the whole section examined.

PLATES XIX, XX

80 Ireland. Socketed spearhead (perhaps originally with side loops).

(1) *Etched (Alcoholic ferric chloride)* ×50
The blade-edge, showing recrystallization and some pools of αδ eutectoid.

(2) *Etched (Ammonia hydrogen peroxide)* ×100
The blade-edge, showing residual coring and recrystallization. Twinning in certain of the crystals may be observed.

PLATES XX, XXI

81 Ireland. Socketed spearhead with loops at base of blade.

(1) *Unetched* ×50
A section showing marked corrosive penetration in the blade, but otherwise the metal is clean and sound.

(2) *Etched (Alcoholic ferric chloride)* ×200
Showing recrystallization in the mass of the metal remote from the edge. Some very small non-metallic inclusions can also be seen.

(3) *Etched (Alcoholic ferric chloride)* ×100
Showing an area of recrystallization at the side of the specimen. This is typical of the whole section examined. Slight relics of dendritic shading commence to appear. At the right-hand side of the field heavy corrosion products may be seen in which are embedded small islands of uncorroded metal.

LATE BRONZE AGE

PLATE XXI

95 Ireland. Socketed axe with one loop.

Etched (Ammonia hydrogen peroxide) ×50
The cutting-edge, showing undisturbed dendritic structure.

PLATES XXI, XXII

96 Co. Antrim, Ireland. Socketed axe with one loop.

(1) *Etched (Ammonia hydrogen peroxide)* ×50
The cutting-edge, showing severe penetrative corrosion attack.

(2) *Etched (Aqueous ferric chloride)* ×100
The cutting-edge, showing deep penetrative corrosion attack, and the general structure of fine-twinned crystals, also lead spots.

(3) *Etched (Aqueous ferric chloride)* ×100
The structure adjacent to the cutting-edge and typical of the whole section examined. The crystals are superimposed on a background of light dendritic shading. A number of lead spots, and non-metallic inclusions, can be seen.

PLATES XXII, XXIII

97 Ireland. Socketed axe with one loop.

(1) *Unetched* ×100
Showing penetrative corrosion at the cutting-edge. The section also contains a number of pools of redeposited copper.

(2) *Etched (Alcoholic ferric chloride)* ×100
View at one side of the section showing twinned crystals, marked penetrative corrosion, spots of lead, and some small non-metallic inclusions which are probably of slaggy origin.

(3) *Etched (Alcoholic ferric chloride)* ×200
Section in the mass of the metal remote from the cutting-edge, showing, as white areas, one large and four small pools of redeposited copper. Some recrystallization can just be seen; also lead spots, and non-metallic inclusions, dove grey in colour, which are probably of slaggy origin.

PLATE XXIII

98 Co. Tyrone, Ireland. Socketed axe with one loop.
Etched (Ammonia hydrogen peroxide) ×50
The cutting-edge, showing slight bending of the residual cores at the extreme tip of the tool.

PLATE XXIV

101 Co. Mayo, Ireland. Socketed axe with one loop.

(1) *Etched (Alcoholic ferric chloride)* ×50
The cutting-edge, showing inclusions flowed round with the metal as a result of mechanical damage.

(2) *Etched (Alcoholic ferric chloride)* ×100
Typical structure at the side of the section remote from the cutting-edge, showing stringers of lead and some small non-metallic inclusions which are probably of slaggy origin.

(3) *Etched (Aqueous ferric chloride)* ×100
Typical of the structure in the mass of the metal of the section examined, showing recrystallization, lead stringers, a pool of $\alpha\delta$ eutectoid, and non-metallic inclusions.

PLATE XXV

109 Tara, Co. Meath, Ireland (?). Socketed knife.

(1) *Etched (Aqueous ferric chloride)* ×50
The cutting-edge, showing recrystallization and relics of dendritic shading.

(2) *Etched (Alcoholic ferric chloride)* ×100
View adjacent to the cutting-edge. The structure comprises twinned crystals superimposed upon relics of dendritic shading, and this is typical of the structure revealed in the whole section examined. Stringers of lead, and small non-metallic inclusions, probably of slaggy origin, were observed.

(3) *Etched (Alcoholic ferric chloride)* ×200
As for (2) above. The view is taken in much the same field, but slightly nearer to the centre of the section.

PLATE XXVI

113 Co. Cork, Ireland. Knife or dirk (?).

(1) *Etched (Alcoholic ferric chloride)* ×20
A section taken from the blade, showing the general dendritic structure.

(2) *Etched (Alcoholic ferric chloride)* ×100
View at one edge of the specimen, showing slight recrystallization superimposed upon dendritic shading, pools of $\alpha\delta$ eutectoid, and small non-metallic inclusions which are probably of slaggy origin.

PLATES XXVI, XXVII

126 Ireland. Socketed spearhead.

(1) *Macro etched* ×30
The cutting-edge, showing porosity, corrosive attack, and the general unsoundness of the metal in this specimen.

(2) *Etched (Alcoholic ferric chloride)* ×200
Showing recrystallization adjacent to the cutting-edge. In this field, while there is porosity, unsoundness is not nearly so marked as in the general mass of the metal.

(3) *Etched (Alcoholic ferric chloride)* ×200
Small twinned crystals seen under relatively high magnification adjacent to the cutting-edge. Slip banding of the crystals was not observed. $\alpha\delta$ eutectoid, non-metallic inclusions, and lead globules are present.

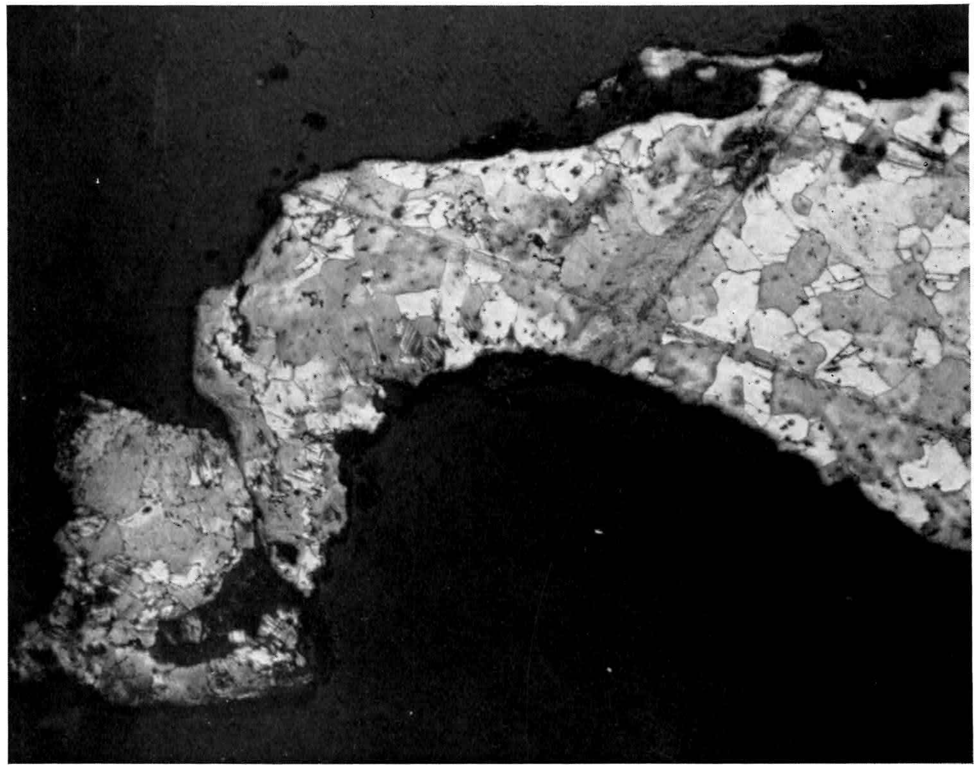
PLATES XXVII, XXVIII

128 Co. Kildare, Ireland. Socketed spearhead.

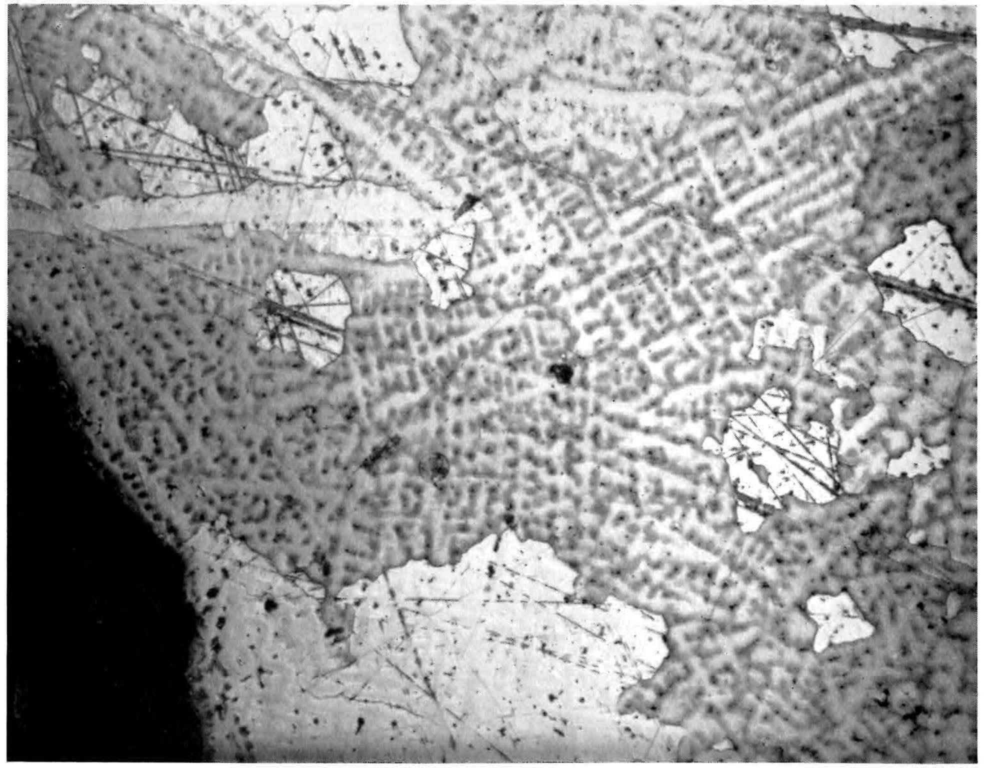
(1) *Unetched* ×50
The cutting-edge, showing a network of lead spots, and one area of corrosion attack at the tip.

(2) *Etched (Ammonia hydrogen peroxide)* ×50
The cutting-edge, showing elongation of the residual cores suggesting forging.

(3) *Etched (Alcoholic ferric chloride)* ×200
A view at one edge of the specimen, showing uncorroded $\alpha\delta$ eutectoid embedded in corrosion products. Some recrystallization superimposed on relics of dendritic shading may also be seen.

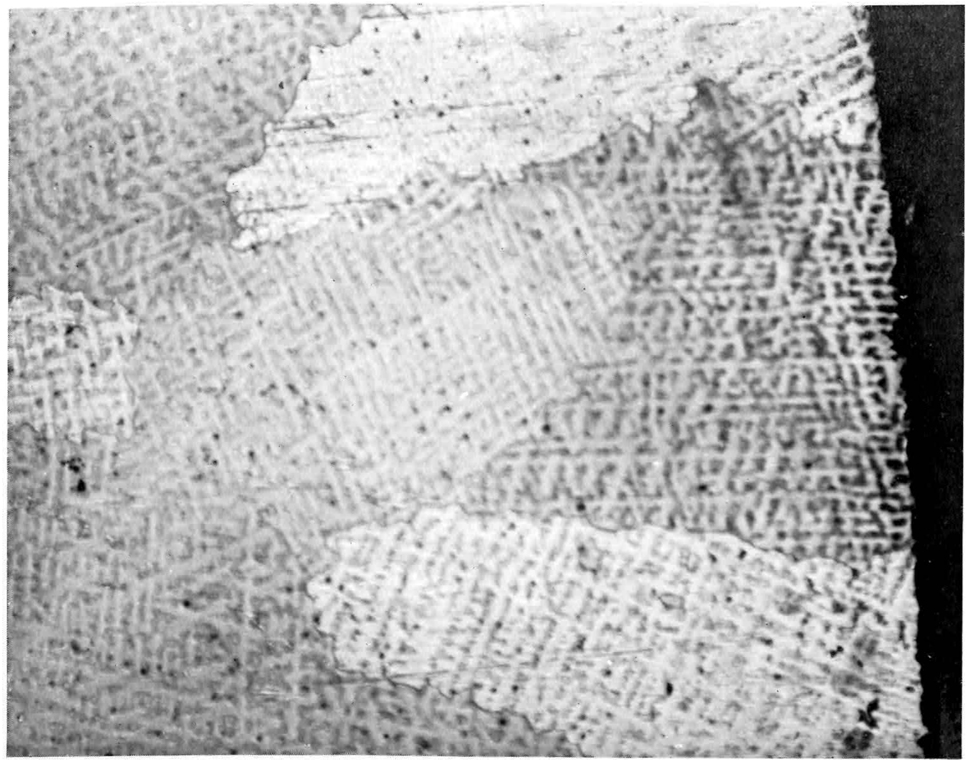


Sickle cast in a stone mould. 'As cast': showing grain size at the cutting-edge. × 30

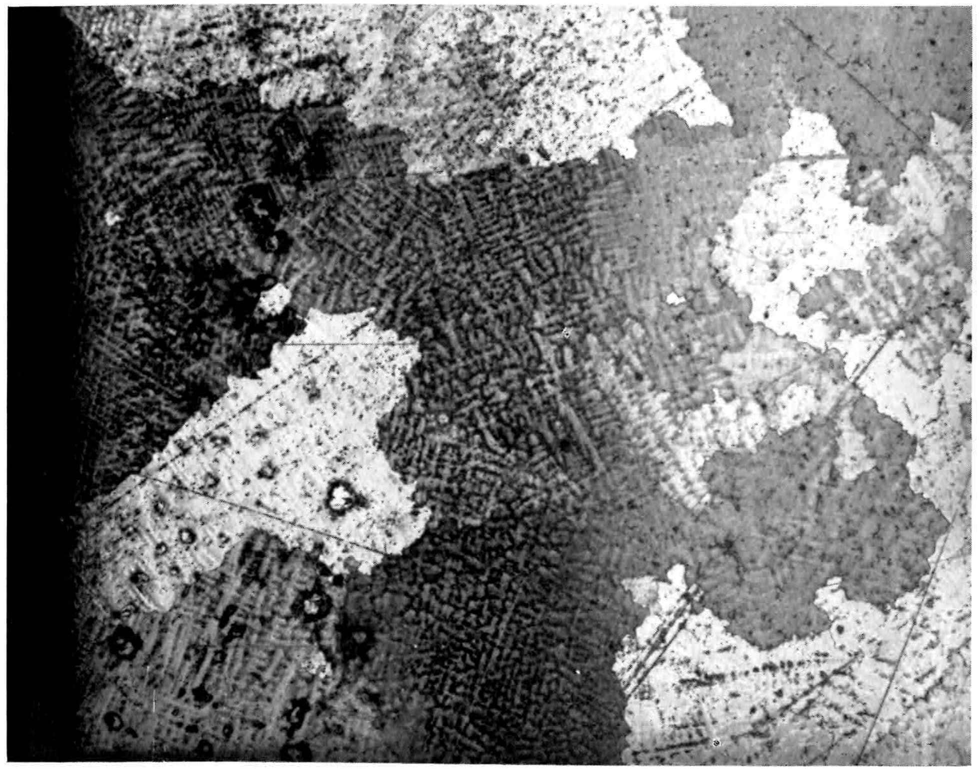


Sickle cast in a stone mould. 'As cast': showing structure adjacent to the cutting-edge. × 30

PLATE II

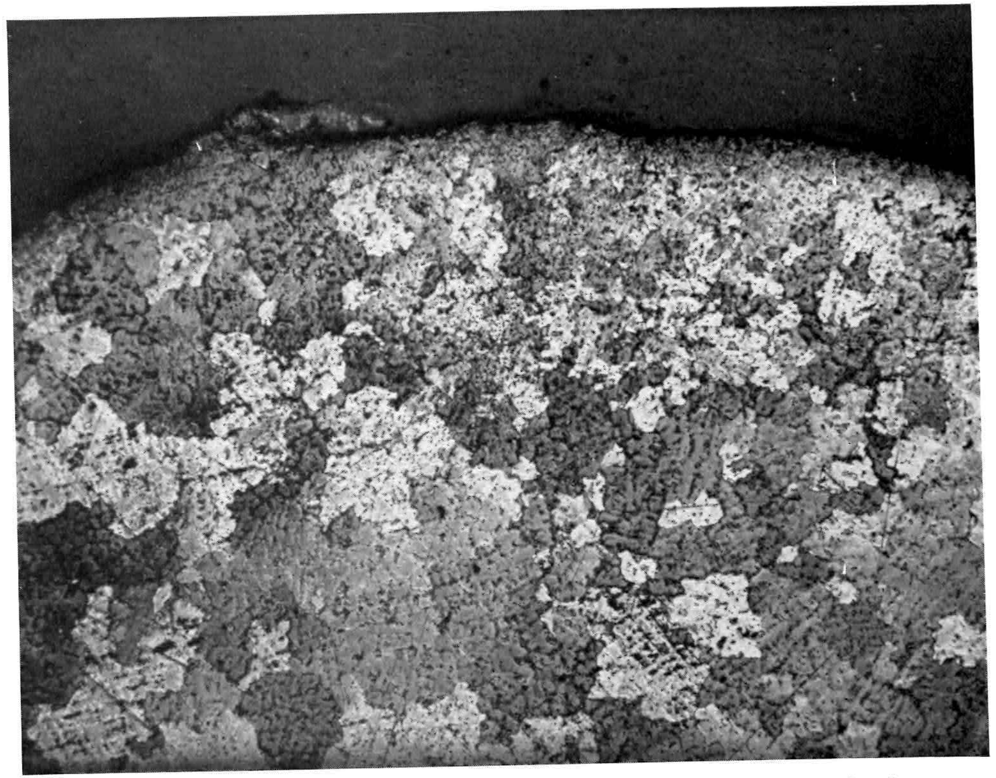


Winged axe cast in a metal mould. Section A. 'As cast': showing the typical dendritic structure. × 30

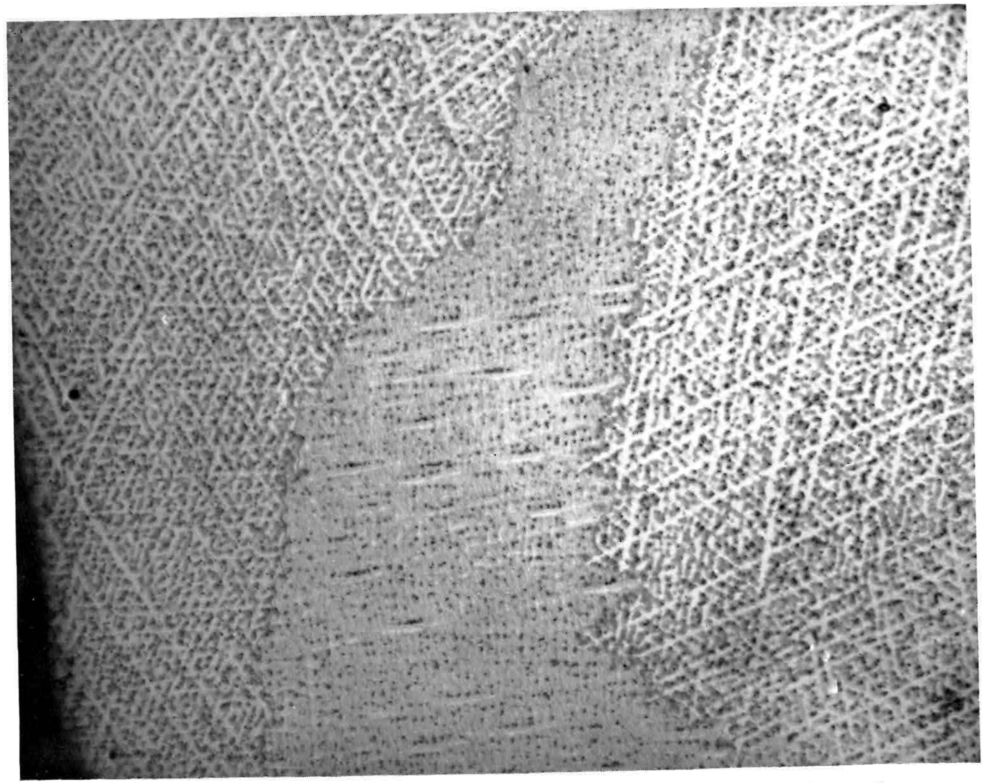


Winged axe cast in a metal mould. Section B. 'As cast': the structure at the side of the flange. × 30

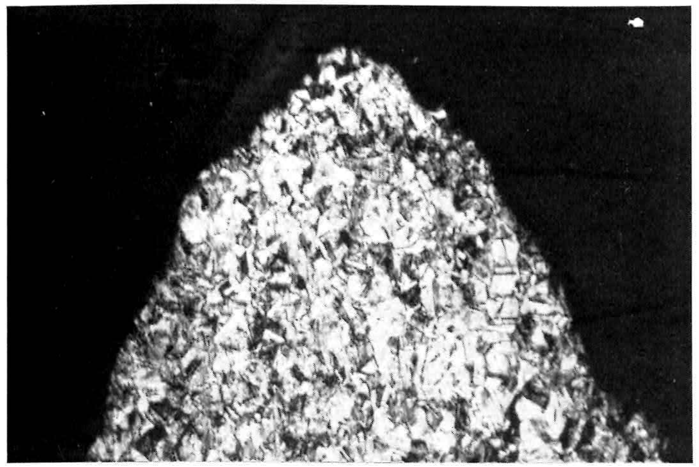
PLATE III



Winged axe cast in a metal mould. Section B. 'As cast': the structure at the thin edge of the flange. × 30



A modern continuously cast bronze: illustrating what appears to be a maximum degree of chill. × 30



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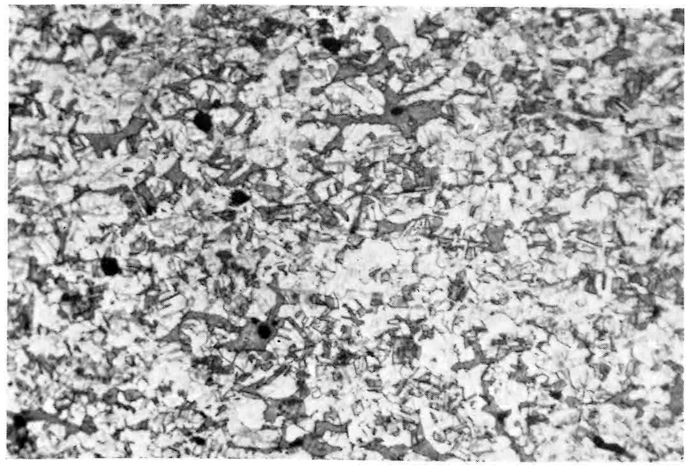

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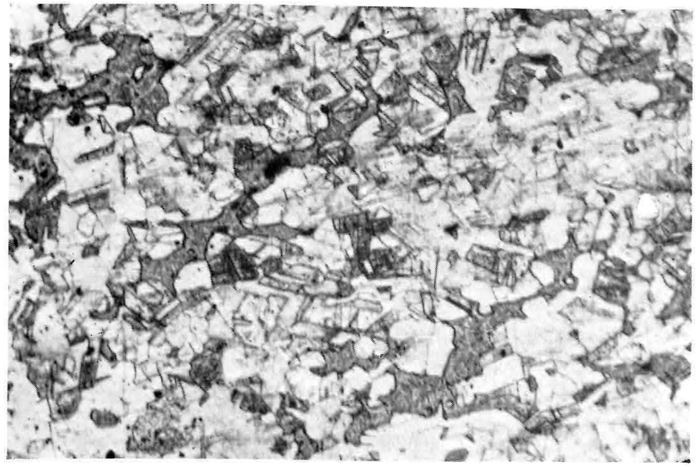
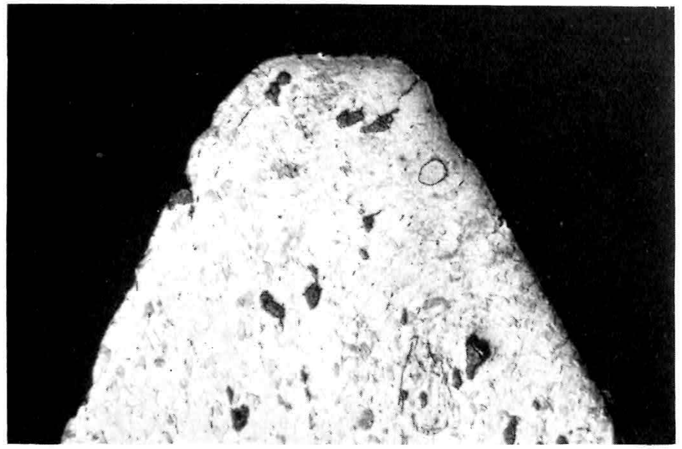


25 (3)

25. Ireland. Axe with slight flanges



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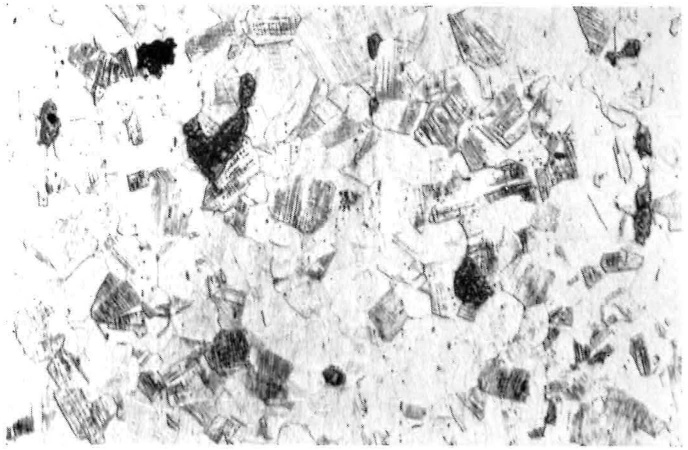

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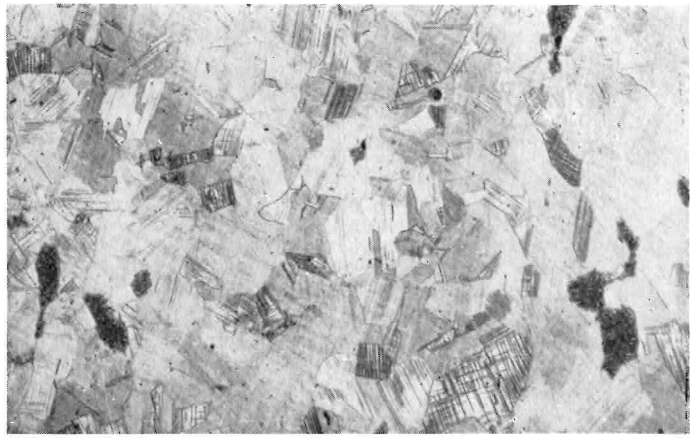
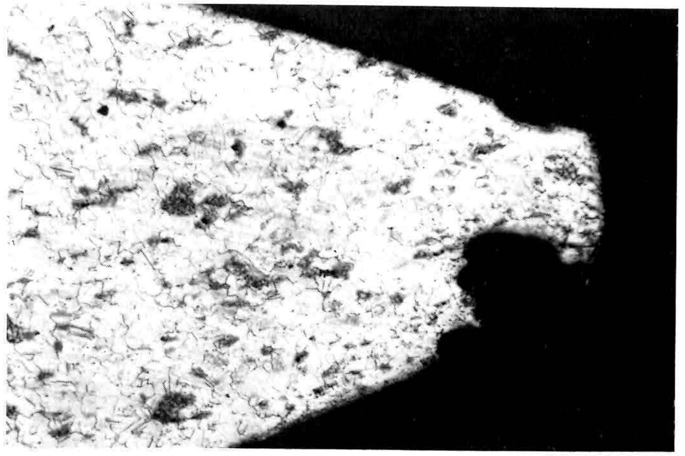


31 (3)

31. Cookstown, Co. Tyrone, Ireland. Flanged axe

PLATE VI



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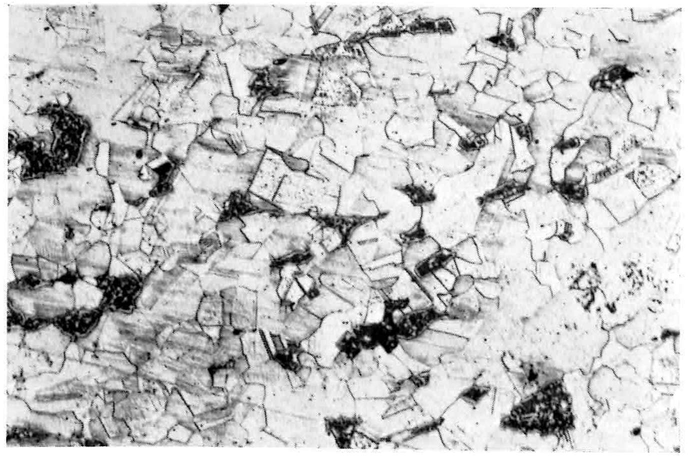

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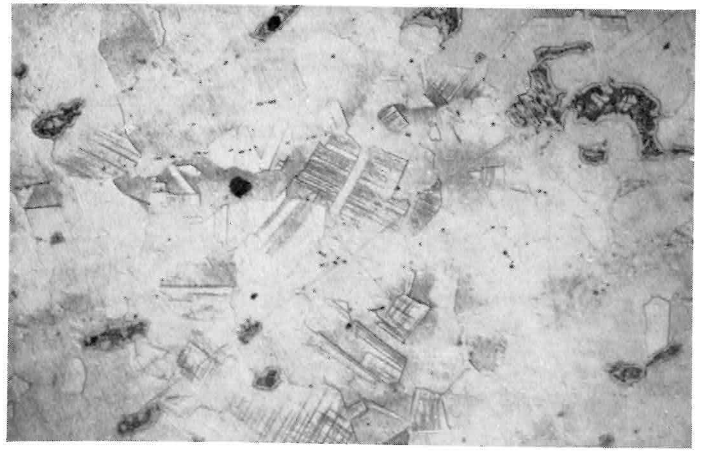
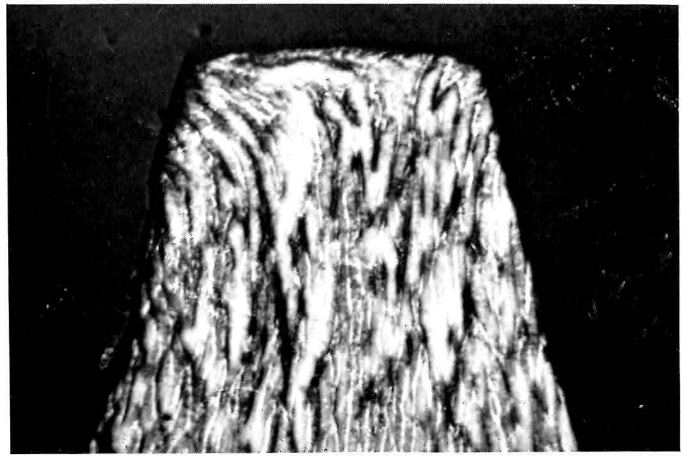


32 (3)

32. Slieve Gallion, Co. Londonderry, Ireland. Flanged axe

PLATE VII



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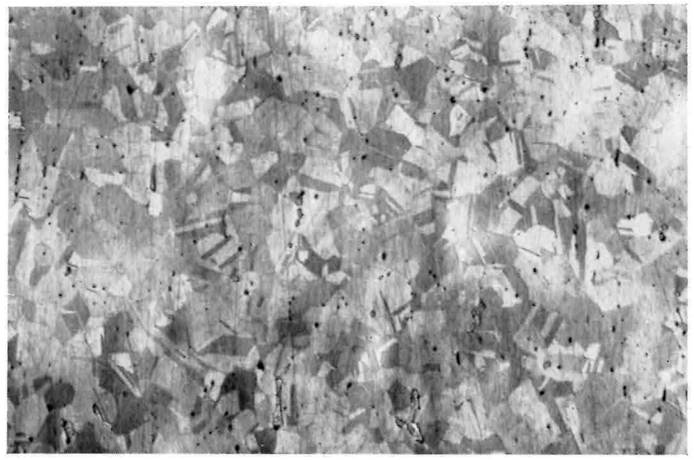

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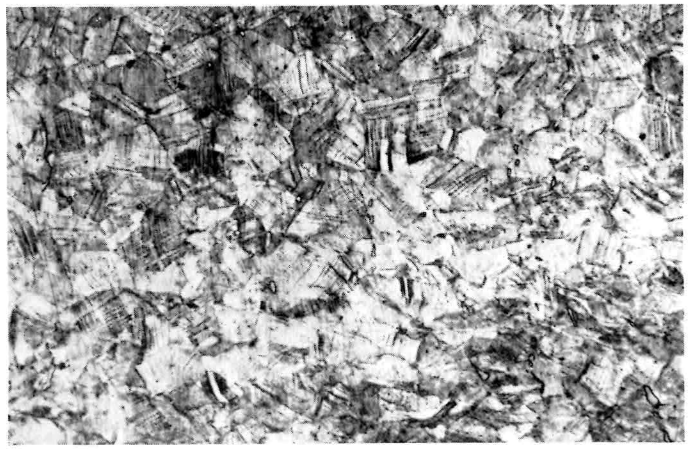

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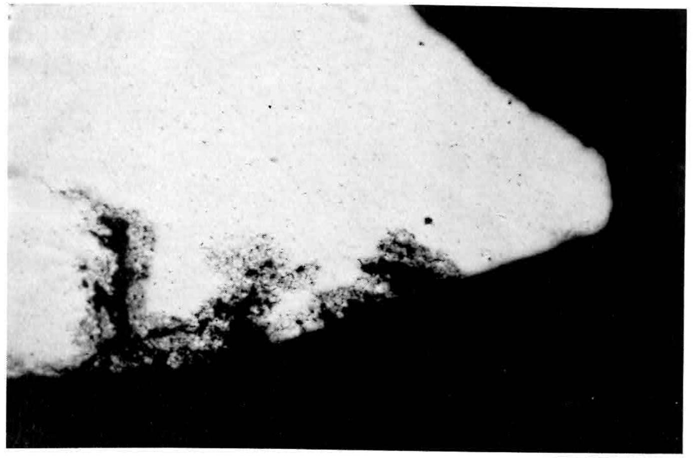
48. Ireland. Palstave



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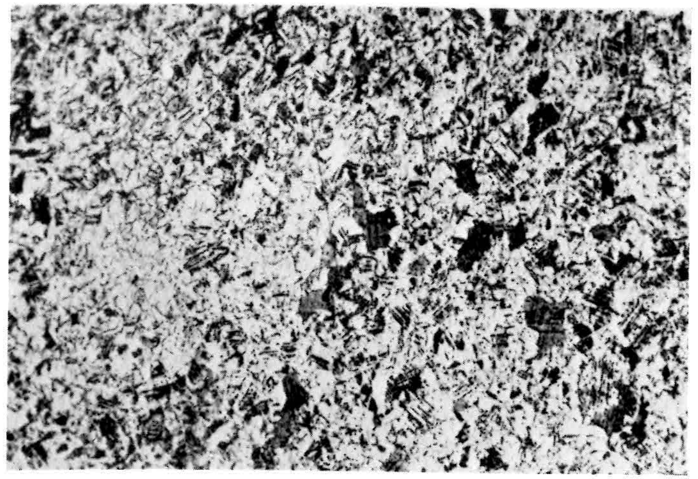

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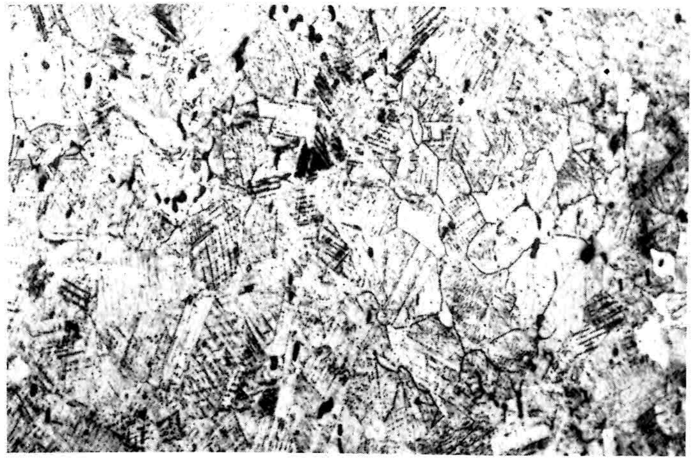
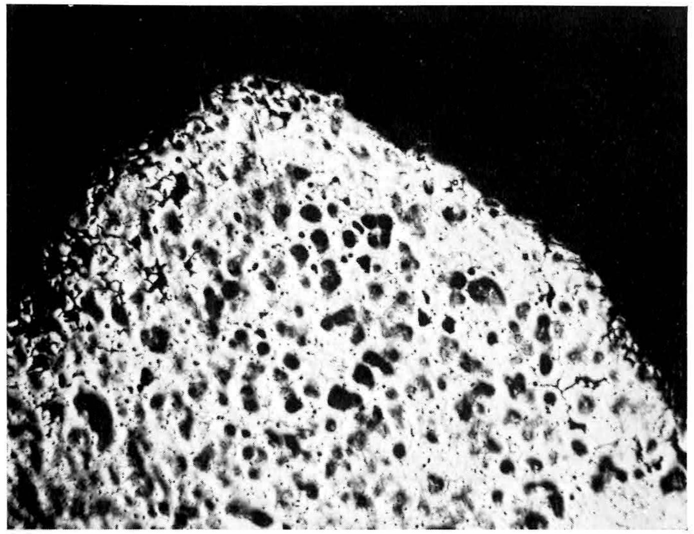


50 (3)

50. Worstead Common, Norfolk. Palstave



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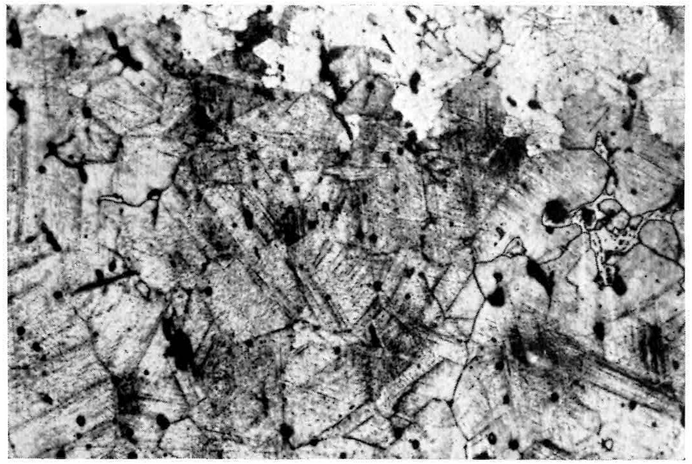

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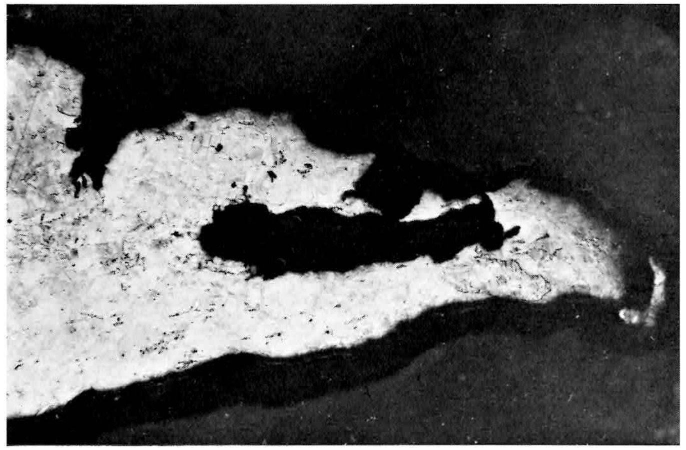
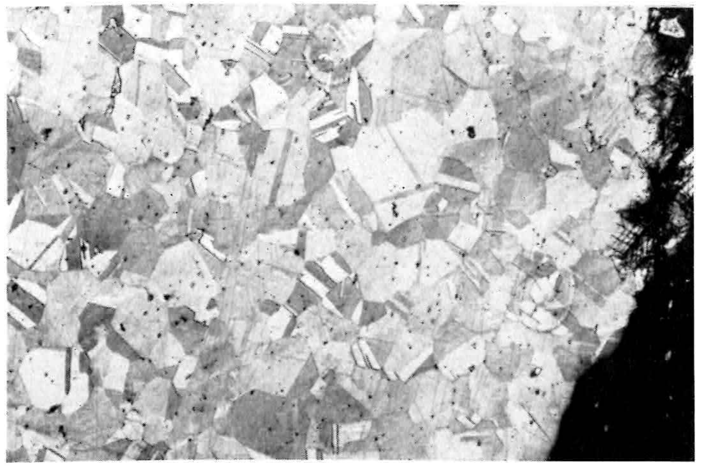


52 (1)

51. Suffolk. Palstave with one loop
52. Suffolk. Palstave with one loop



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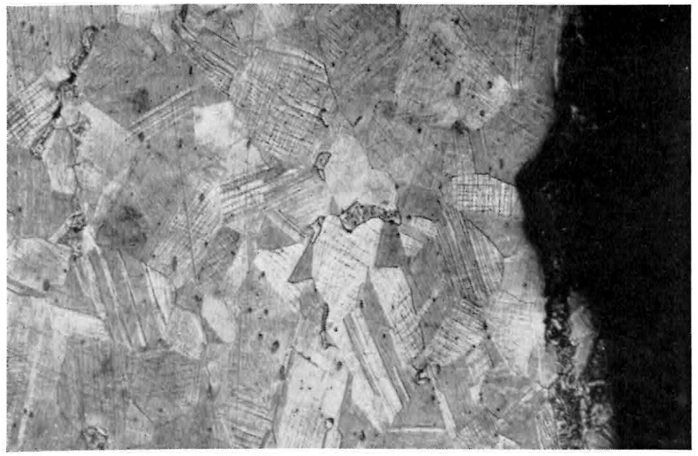

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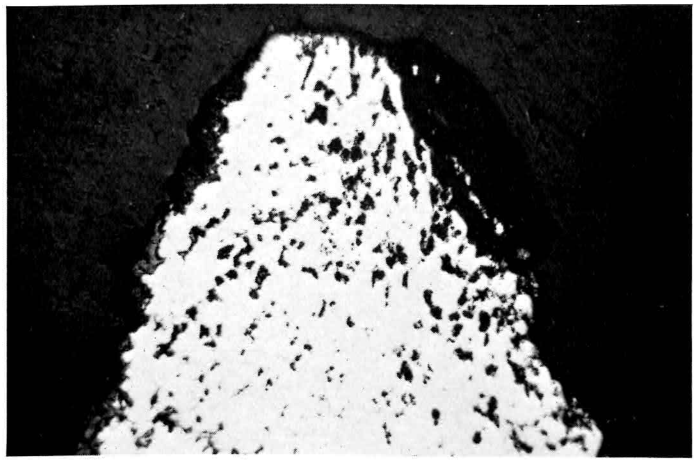

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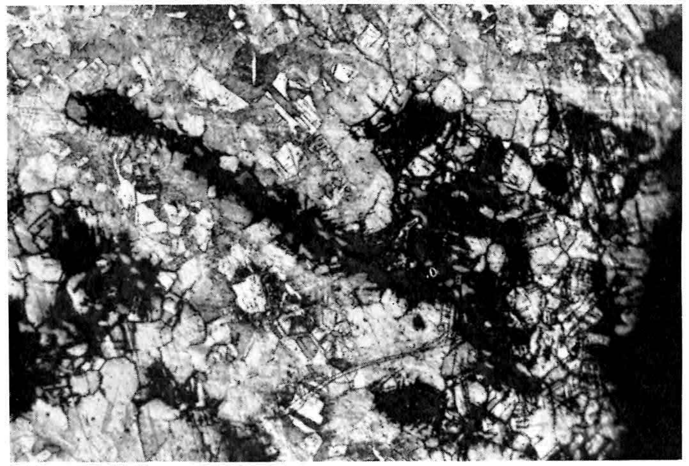
52. Suffolk. Palstave with one loop
54. Mettingham, Suffolk. Palstave with one loop



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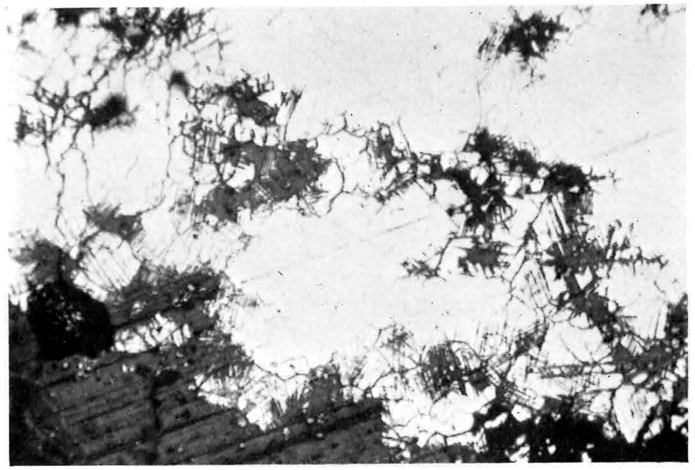

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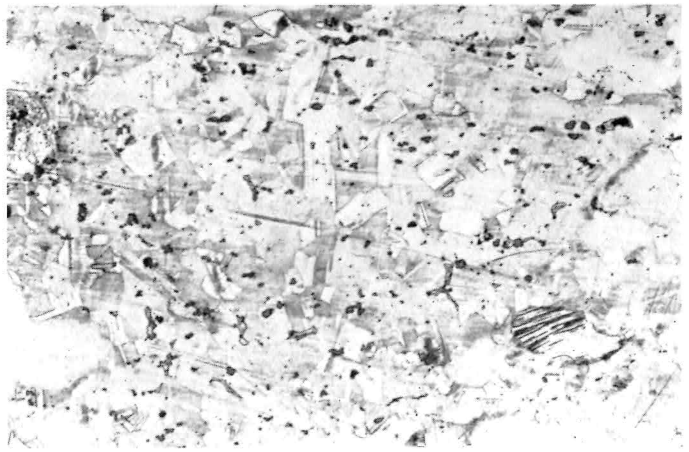
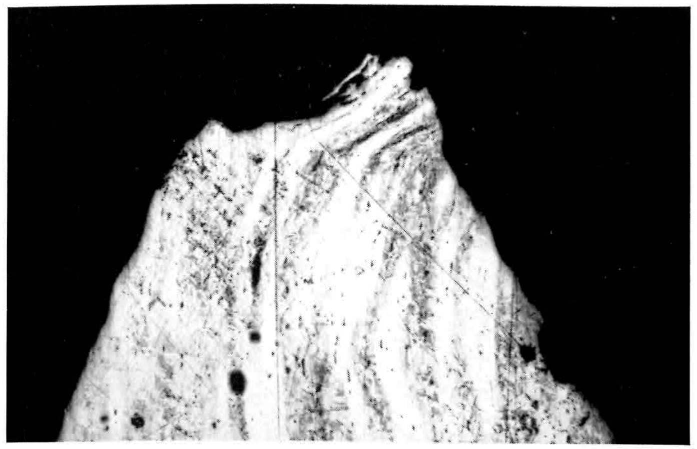


54 (4)

54. Mettingham, Suffolk. Palstave with one loop



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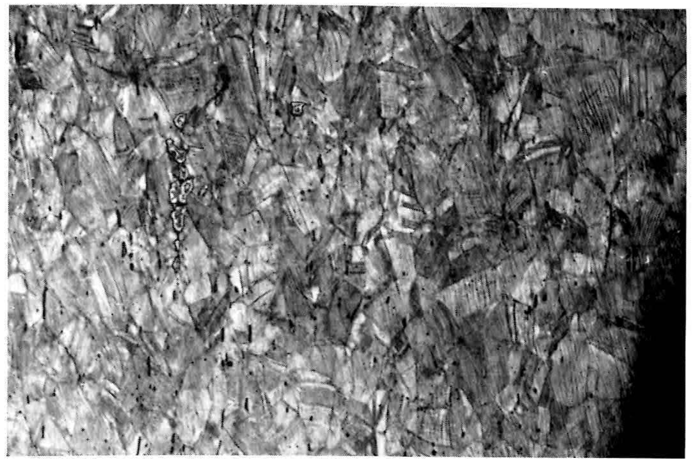

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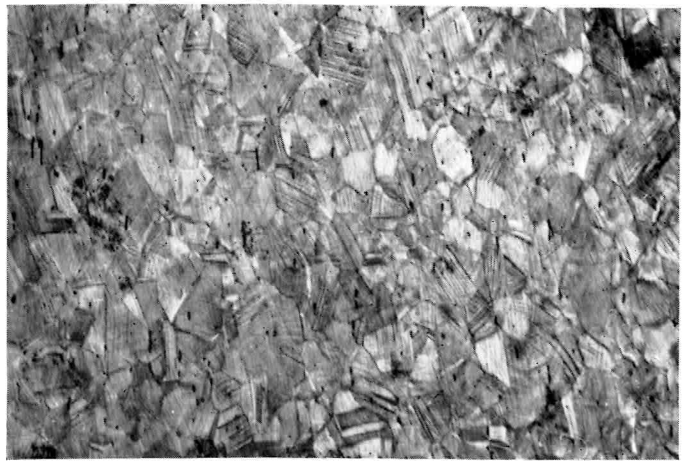
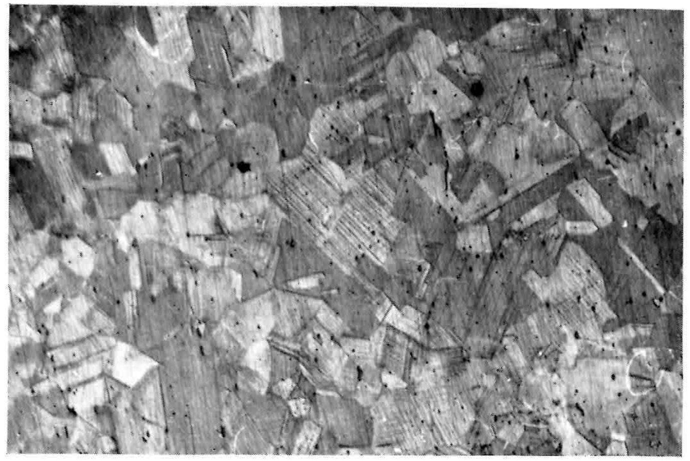


55 (3)

55. Near Pusey, Berkshire. Palstave



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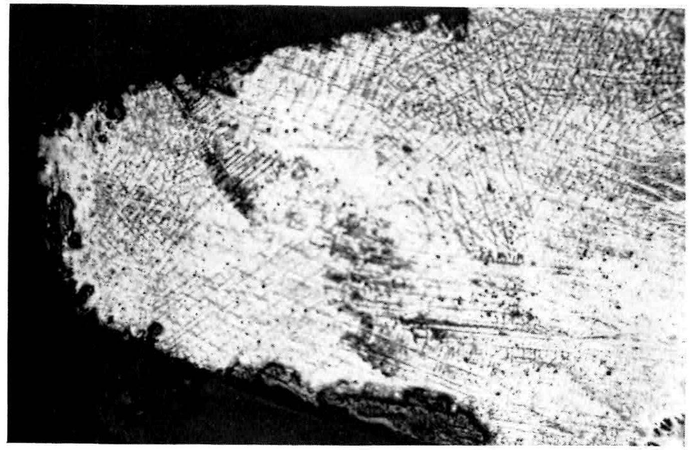

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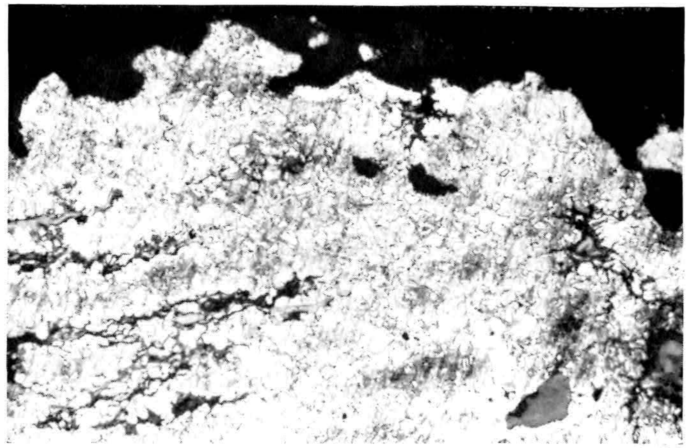
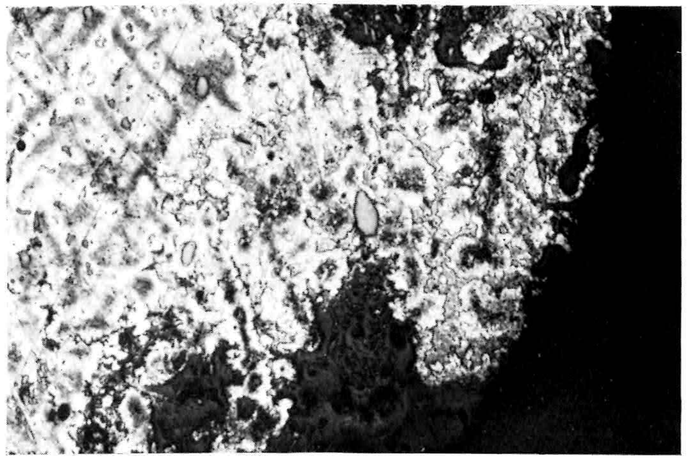


56 (2)

55. Near Pusey, Berkshire. Palstave
56. From the Thames, Wandsworth, London. Palstave



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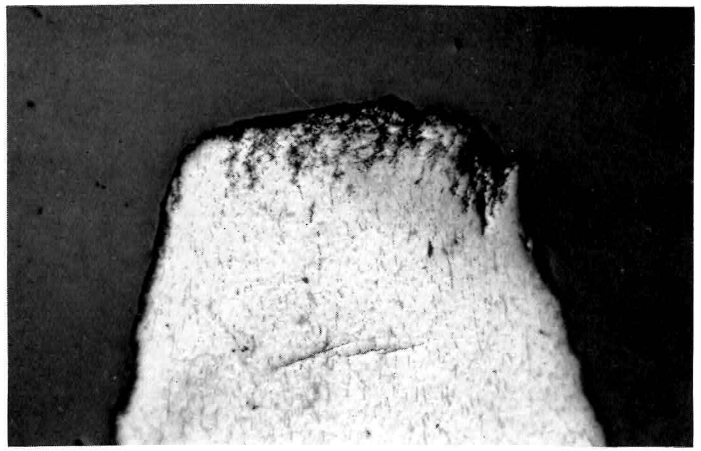

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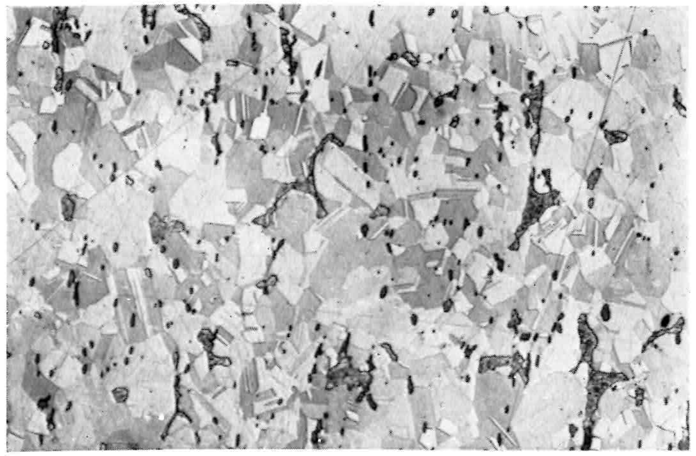
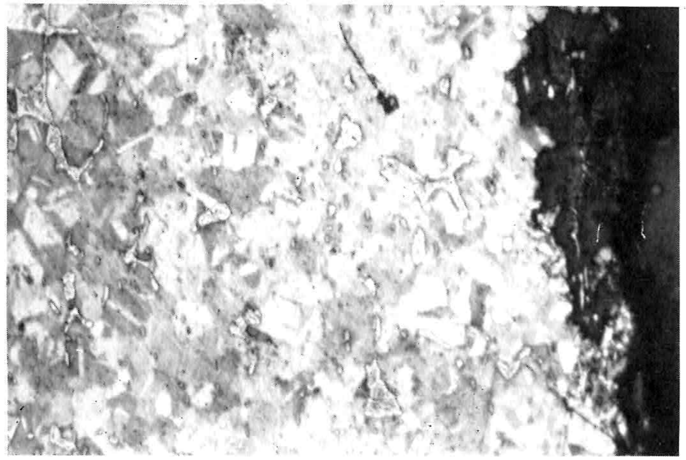


58 (2)

56. From the Thames, Wandsworth, London. Palstave
58. Ireland. Palstave



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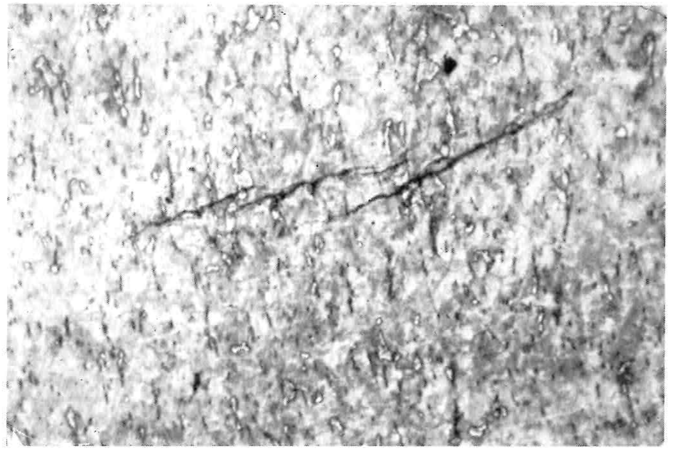

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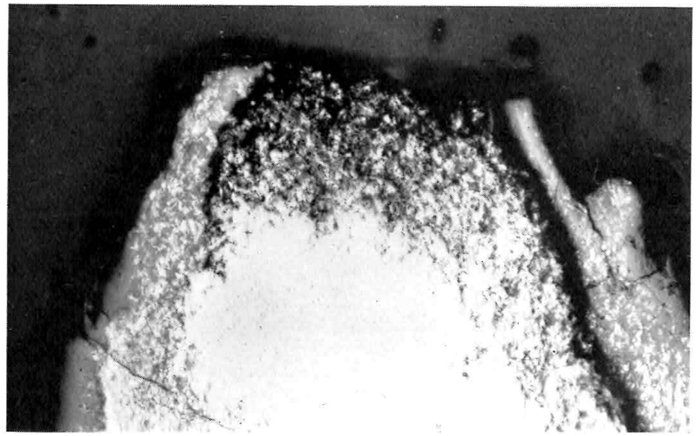
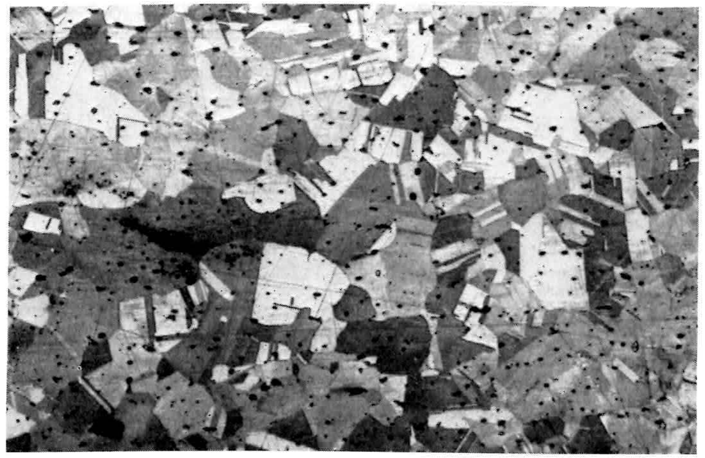


60 (1)

58. Ireland. Palstave
60. Ireland (?). Palstave

PLATE XVI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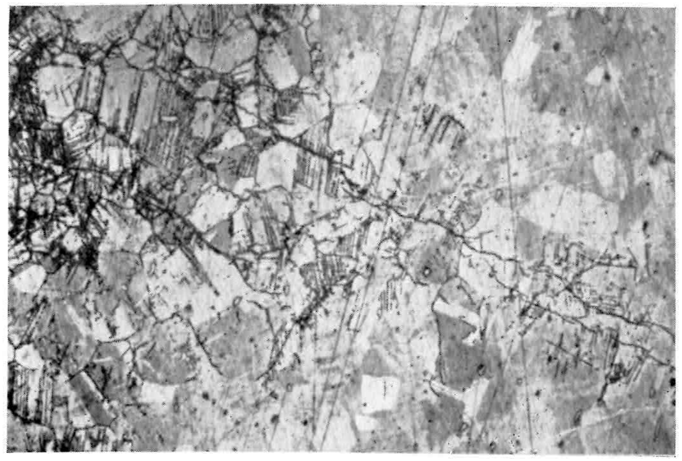
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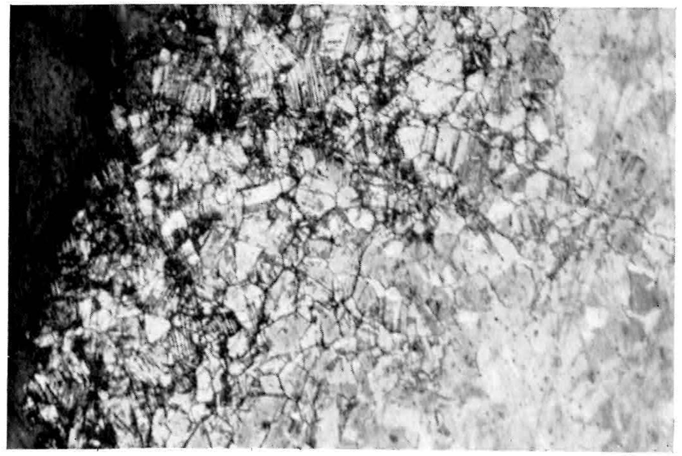
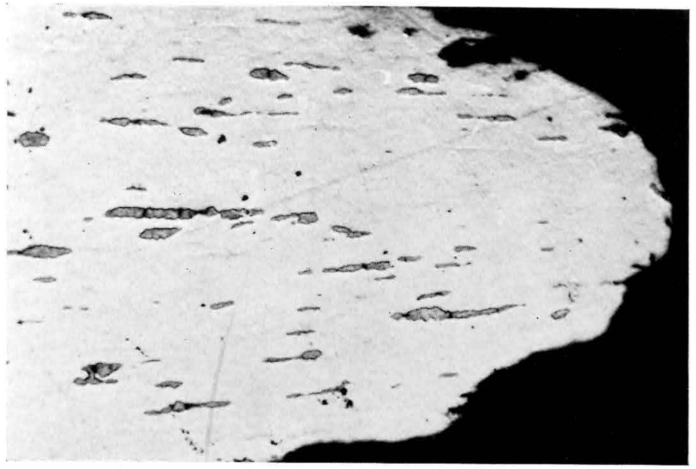
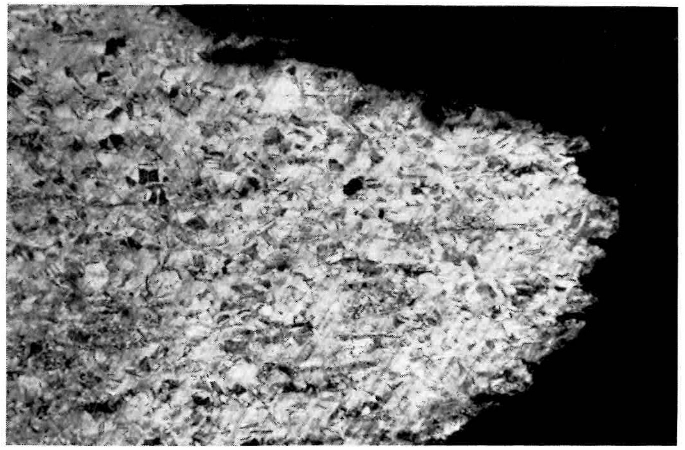

60 (4)

60. Ireland (?). Palstave

PLATE XVII


63 (1)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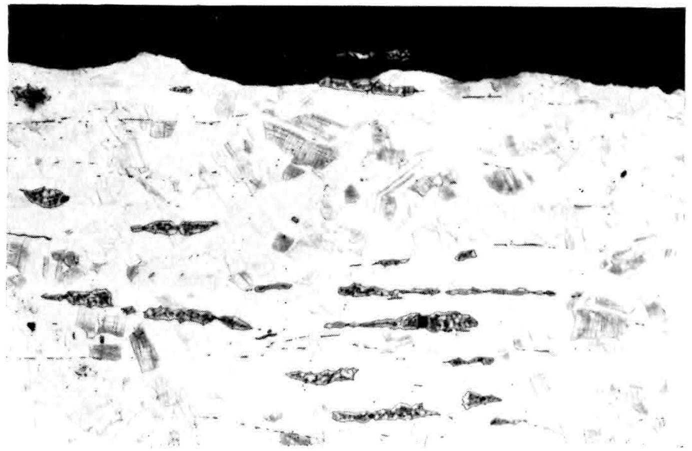
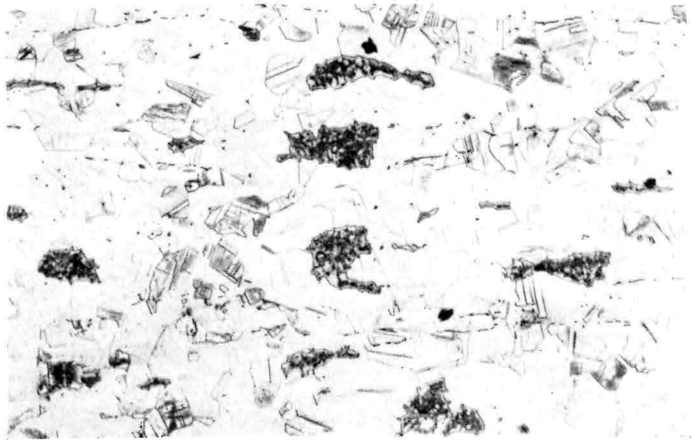
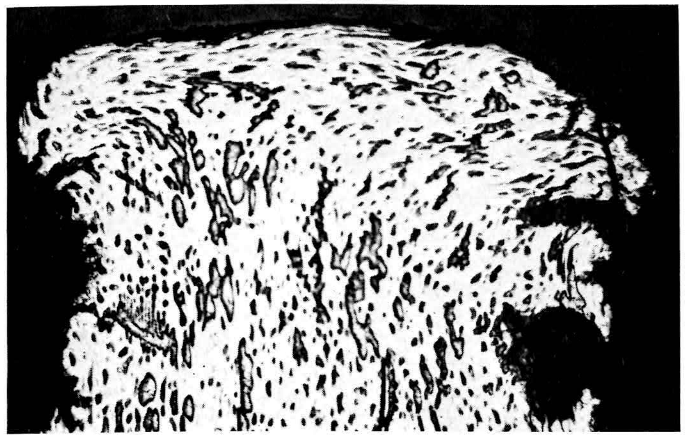

63 (3)

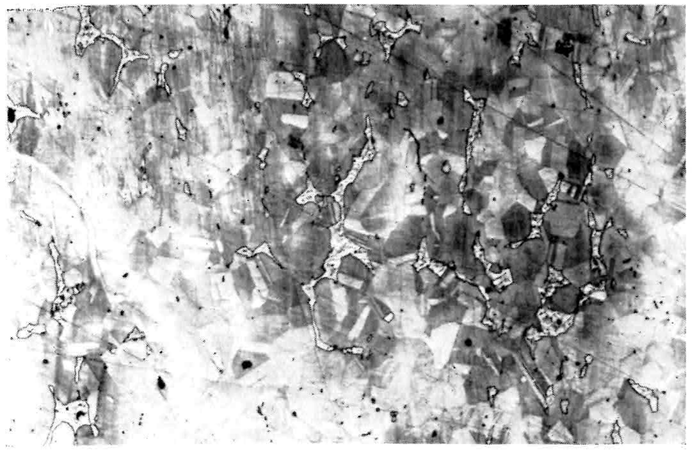
63. Co. Mayo, Ireland. Haft-flanged axe



63 (4)

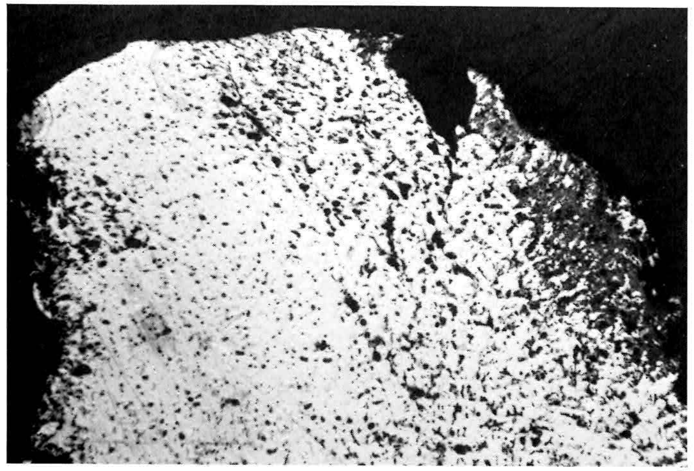


64 (1)

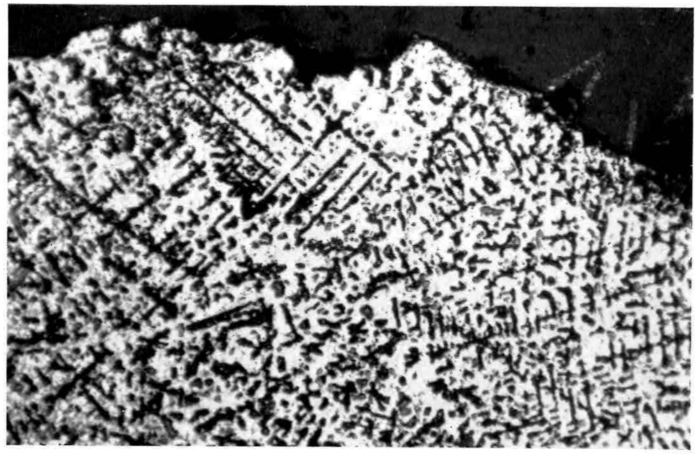


64 (2)

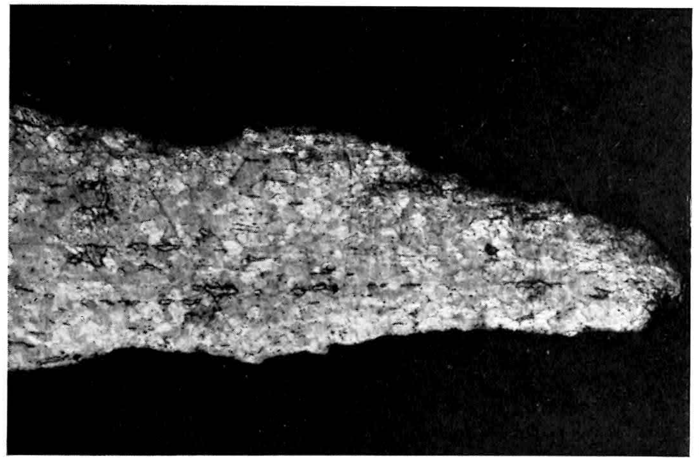
63. Co. Mayo, Ireland. Haft-flanged axe
64. Co. Mayo, Ireland. Wing-flanged palstave



65 (1)



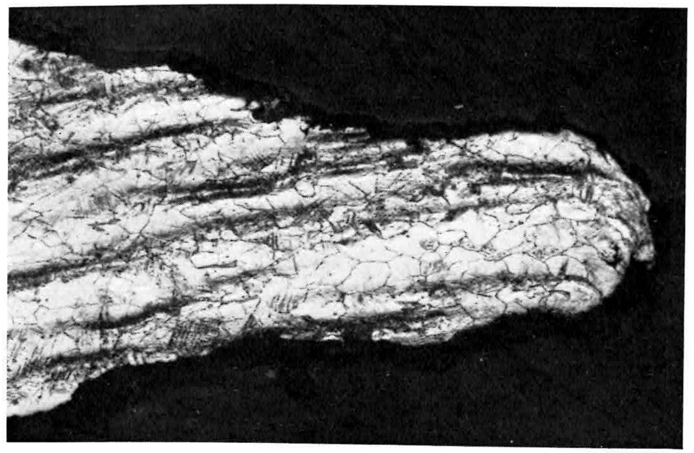
65 (2)



80 (2)

65. Co. Mayo, Ireland. Flanged axe
80. Ireland. Socketed spearhead (perhaps originally with side loops)

PLATE XX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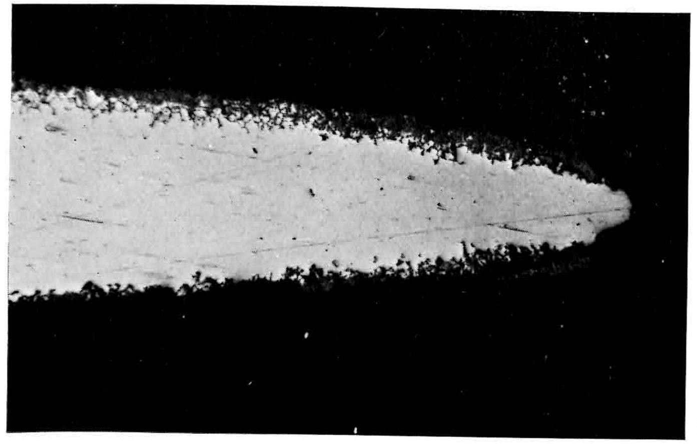
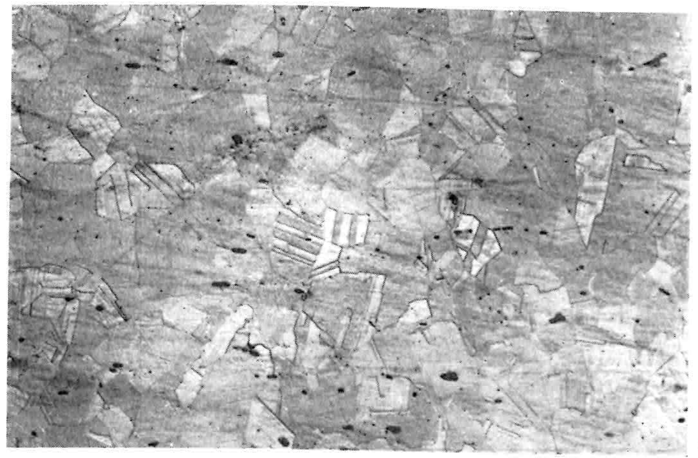
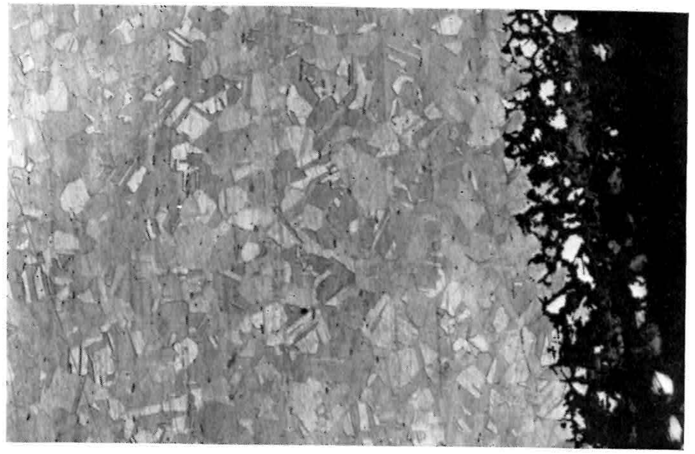
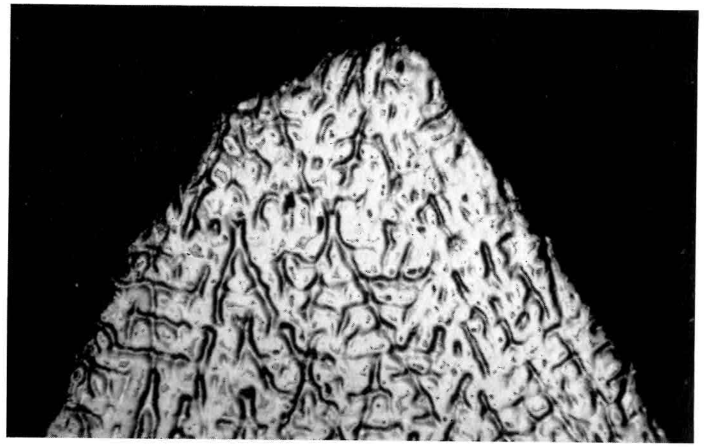

81 (1)

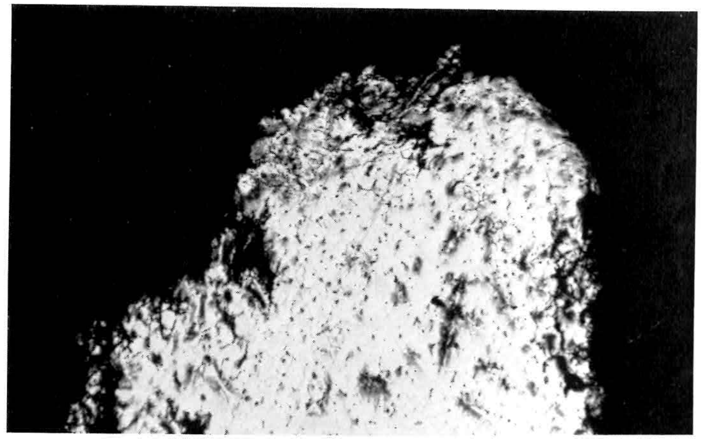

81 (2)

80. Ireland. Socketed spearhead (perhaps originally with side loops)
81. Ireland. Socketed spearhead with loops at base of blade

PLATE XXI

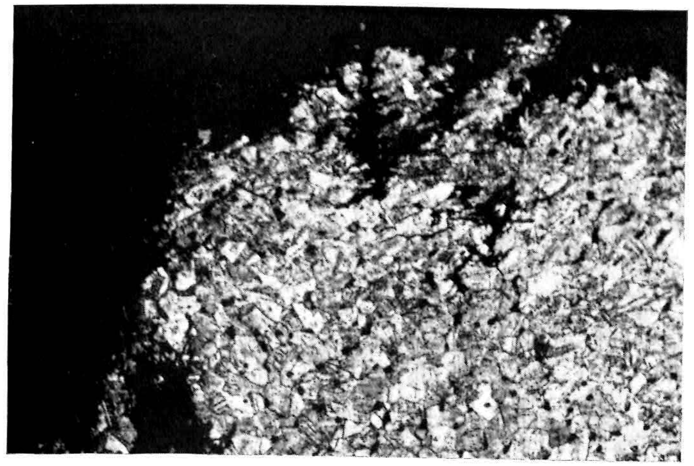

81 (3)


95 (1)

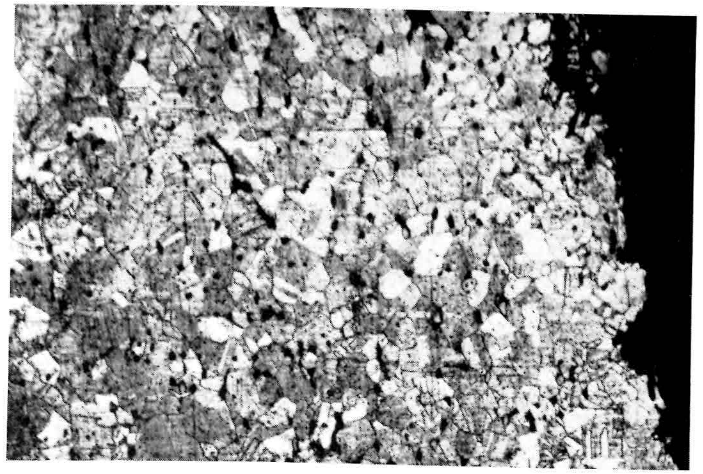

96 (1)

81. Ireland. Socketed spearhead with loops at base of blade
95. Ireland. Socketed axe with one loop
96. Co. Antrim, Ireland. Socketed axe with one loop

PLATE XXII



96 (2)



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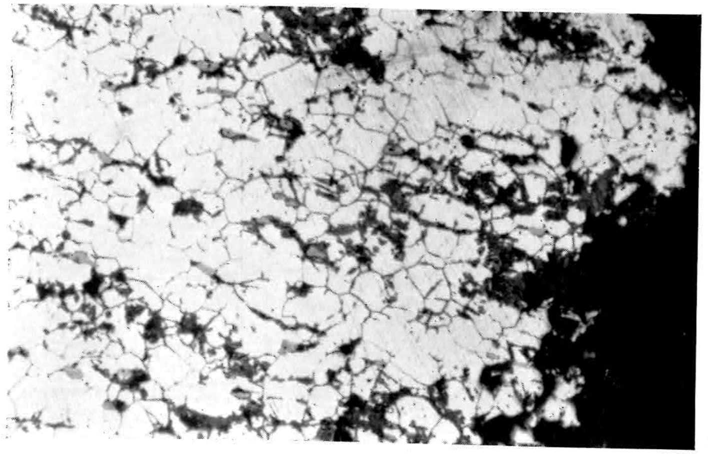
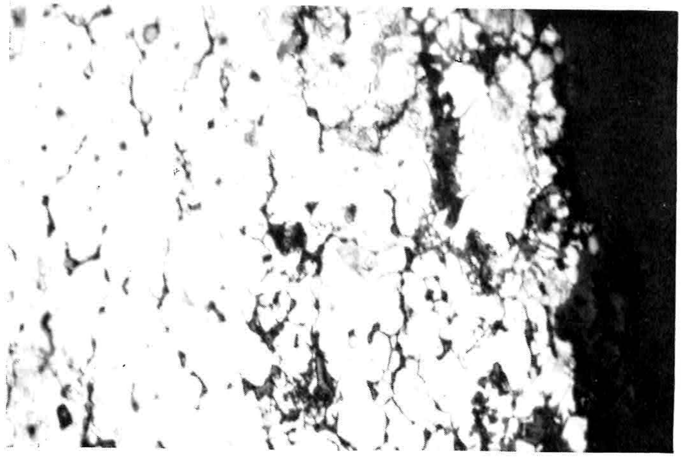


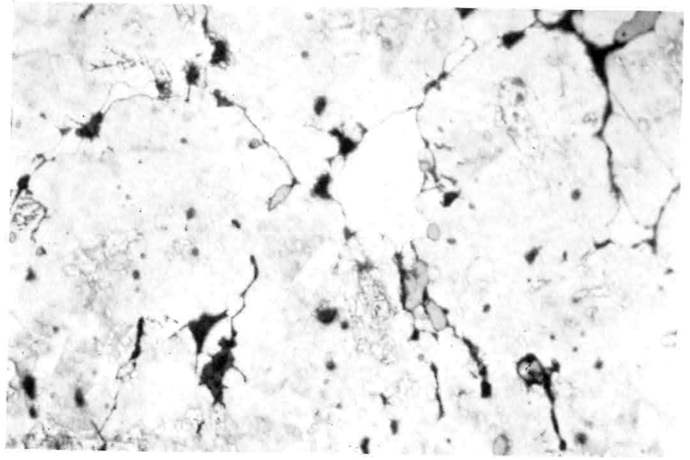
97 (1)

96. Co. Antrim, Ireland. Socketed axe with one loop
97. Ireland. Socketed axe with one loop

PLATE XXIII



97 (2)



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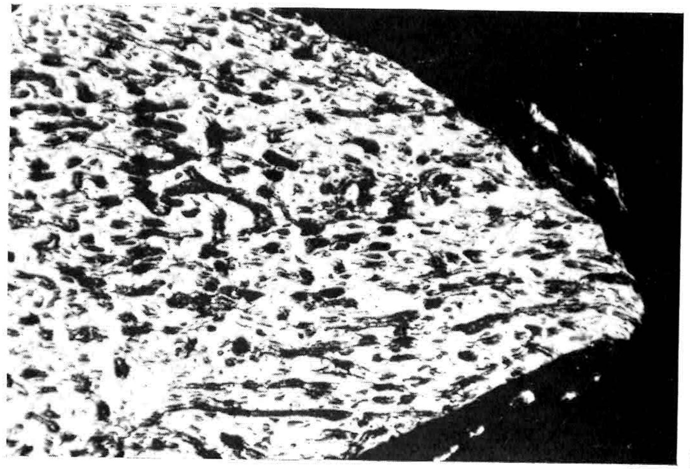
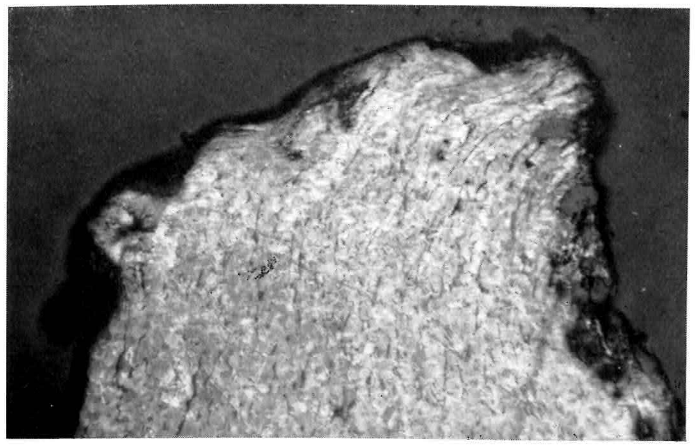


98 (1)

97. Ireland. Socketed axe with one loop
98. Co. Tyrone, Ireland. Socketed axe with one loop



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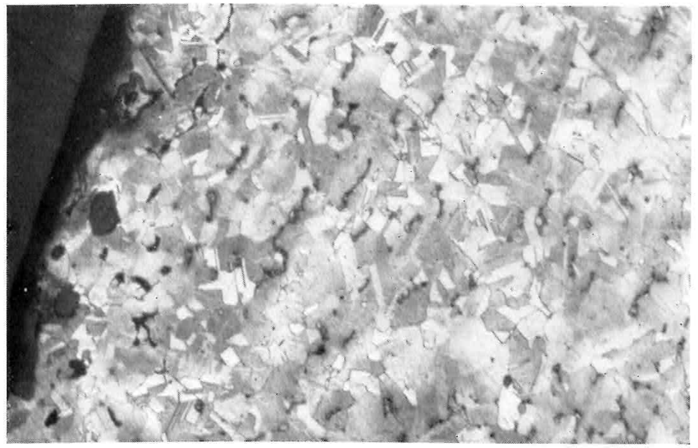

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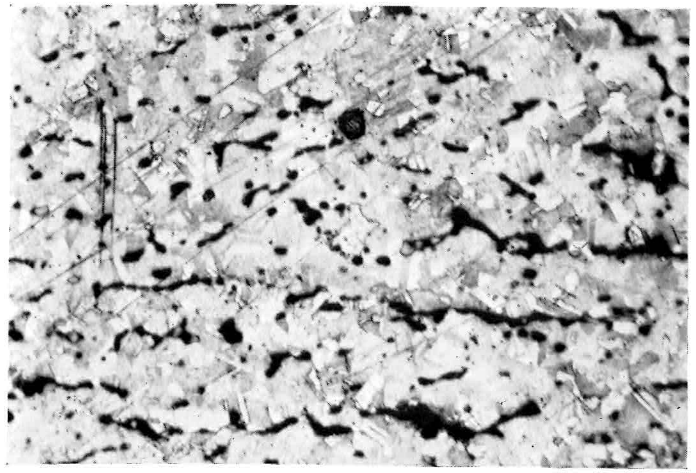
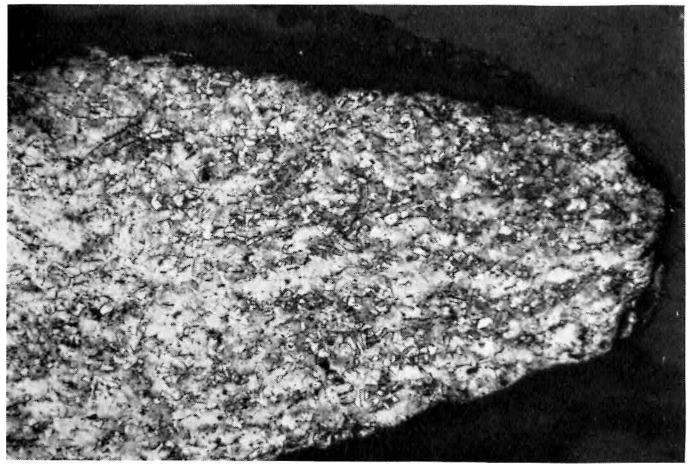
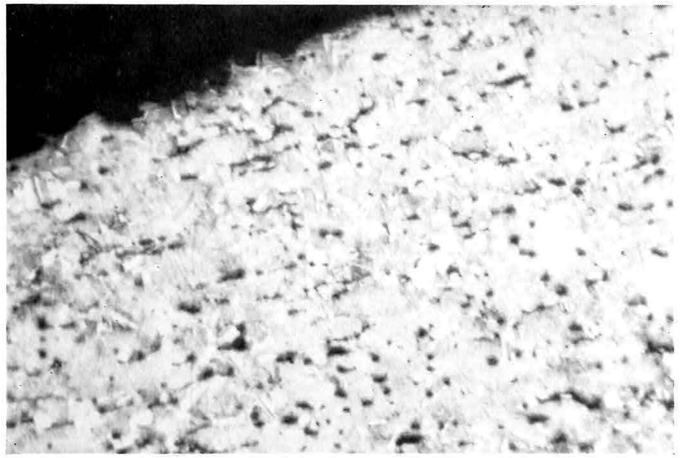


101 (3)

101. Co. Mayo, Ireland. Socketed axe with one loop



109 (1)



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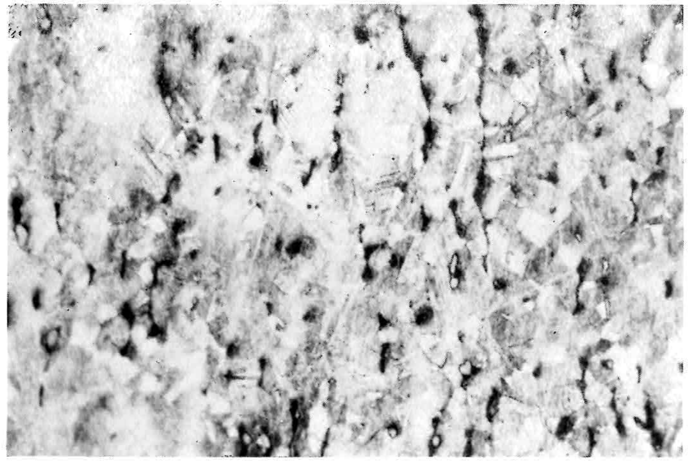
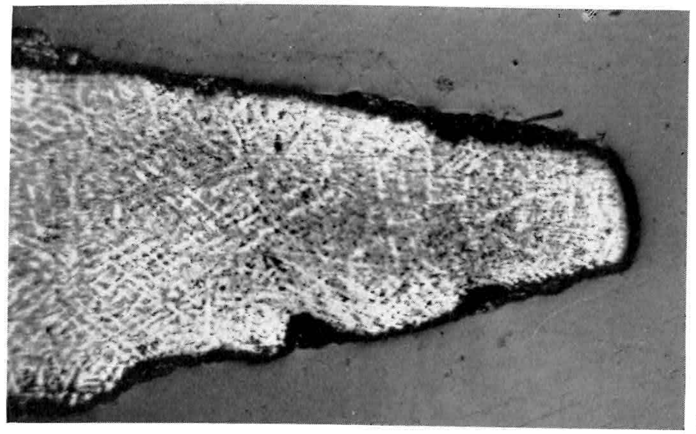


109 (3)

109. Tara, Co. Meath, Ireland (?). Socketed knife



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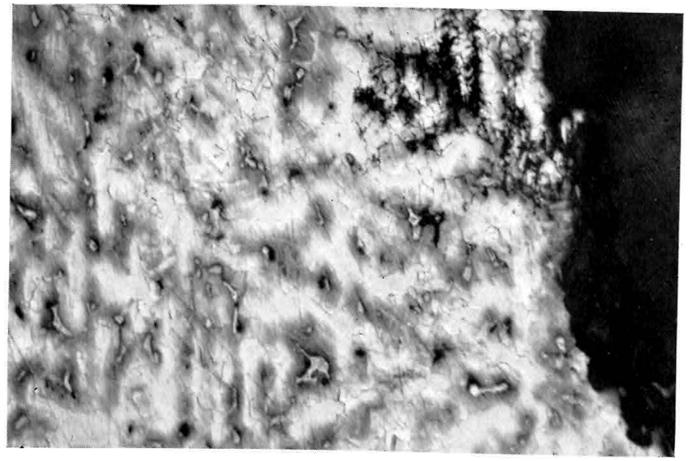
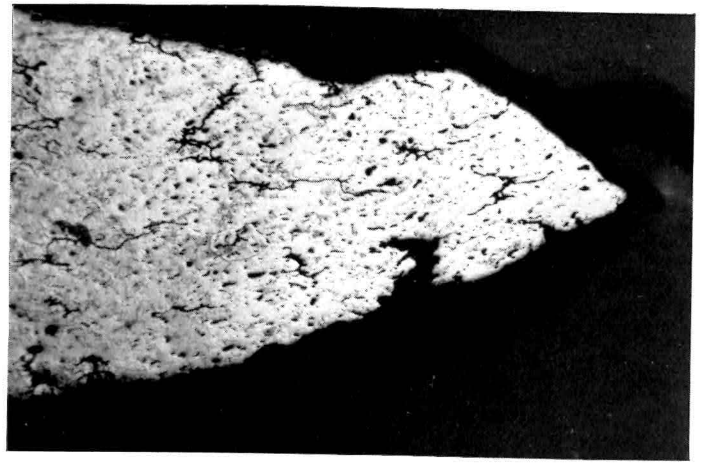
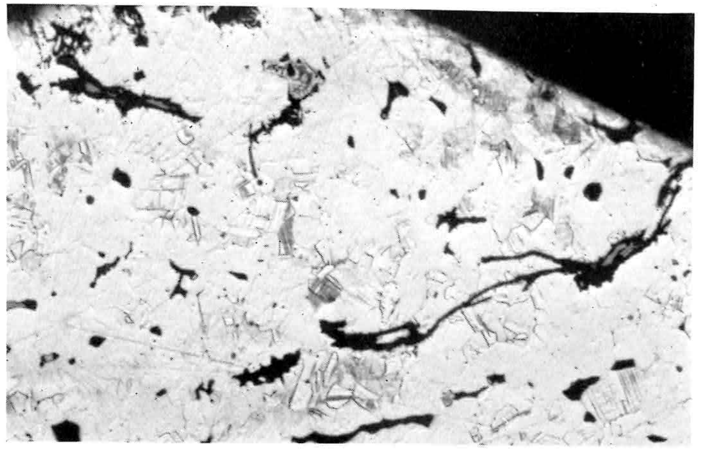


113 (2)

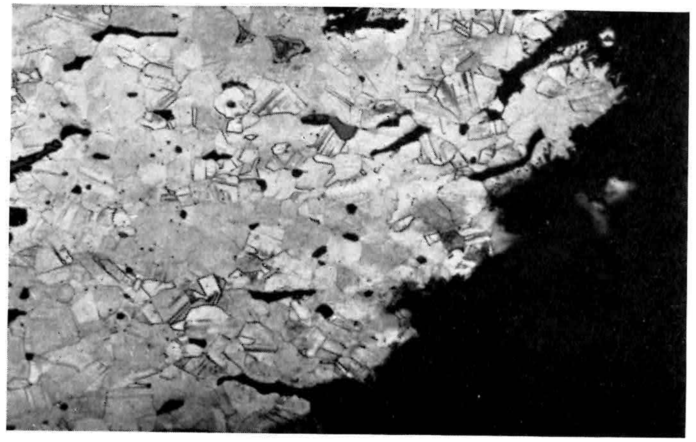


126 (1)

113. Co. Cork, Ireland. Knife or dirk (?)
126. Ireland. Socketed spearhead



126 (2)



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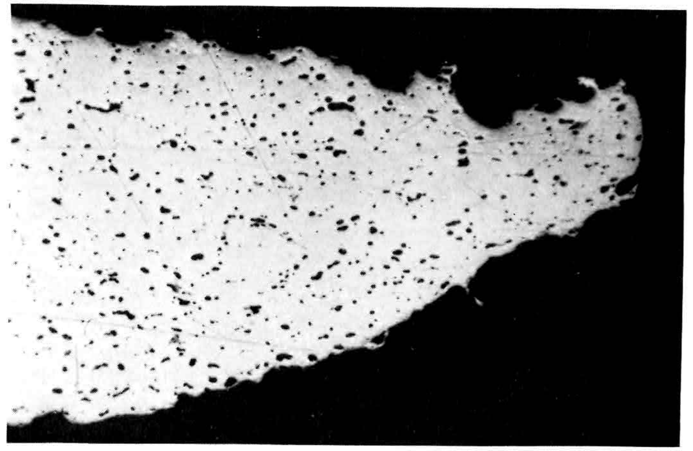
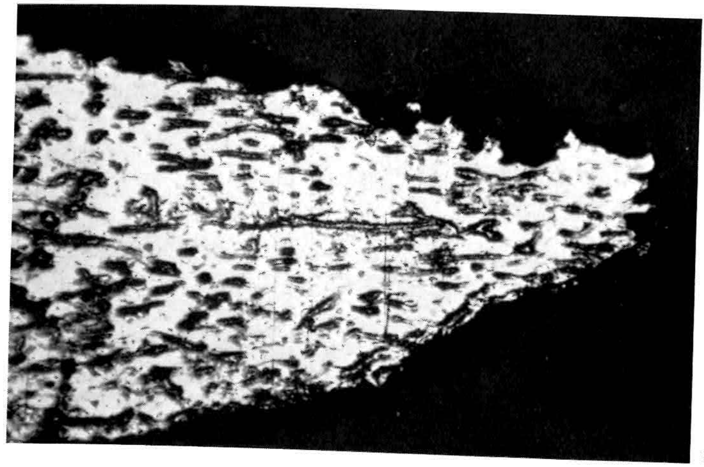


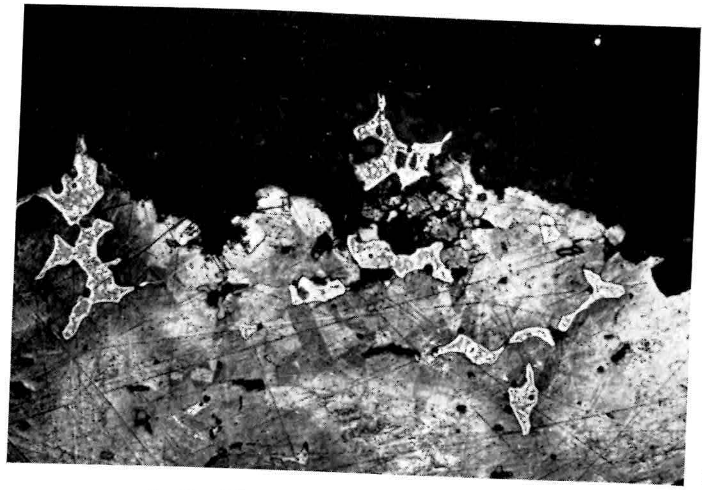
128 (1)

126. Ireland. Socketed spearhead
128. Co. Kildare, Ireland. Socketed spearhead

PLATE XXVIII



128 (2)



128 (3)

128. Co. Kildare, Ireland. Socketed spearhead

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